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ARMY AVIATION TEST BOARD FORT RUCKER ALA
MILITARY POTENTIAL TEST OF ARMY AIRCRAFT SPARK PLUGS, PL 300.(U)
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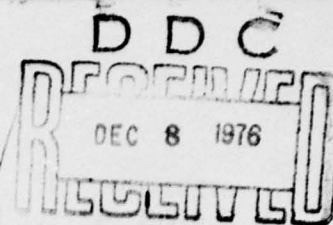


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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360



STEBG-TD

24 MAR 1966

SUBJECT: Letter Report of Military Potential Test of Army Aircraft
Spark Plugs, PL 300, USATECOM Project No. 4-6-5400-01N

TO: Commanding General
US Army Aviation Materiel Command
ATTN: SMOSM-EERG
12th and Spruce Streets
St. Louis, Missouri 63166

1. References.

- a. MIL-S-7886/1002 (MO), "Military Specification Spark Plugs: Shielded Fine Wire Platinum Electrode, Type I for Aircraft Reciprocating Engines," 23 October 1963.
- b. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 18 August 1964, subject: "Test Directive USATECOM Project No. 4-5-5407-01, Military Potential Test of Army Aircraft Spark Plugs AC-281, FSN 2925-328-2019."
- c. Letter, SMOSM-EERG, Headquarters, US Army Aviation Materiel Command, 11 January 1965, subject: "Plan of Test For Spark Plugs for OH-13S Aircraft."
- d. US Army Aviation Test Board Plan of Test for Military Potential Test of Army Aircraft Spark Plugs RHB 36P, FSN 2525-801-8456, 5 March 1965.
- e. Letter, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 26 August 1965, subject: "Flight Test of Autolite Spark Plug PL 300."

2. Authority.

- a. Directive. Letter, SMOSM-EGCG, Headquarters, US Army Aviation Materiel Command, 16 August 1964, subject: "Flight Testing of Army Spark Plugs," with 1st Indorsement, AMSTE-BG, Headquarters, US Army Test and Evaluation Command, 7 September 1965.

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Spark Plugs, PL 300, USATECOM Project No. 4-6-5400-01

b. Purpose. To determine suitability and reliability of the PL 300 Spark Plugs when used in the CV-2 aircraft.

3. Objectives.

To determine:

a. Capability of the test spark plugs to operate in accordance with military specifications for 400 flight hours when installed in the R2000-7M2 engine.

b. Condition of the spark plugs at test completion or when failure or malfunction occurs.

4. Description of Materiel.

a. PL 300 Spark Plug. The PL 300 is a shielded, fine-wire, platinum-electrode, type I spark plug.

b. R2000-7M2 Engine. The R2000-7M2 engine is a two-row, 14-cylinder (7 cylinders per row), radial, air-cooled engine with a single-stage, single-speed super charger. The propeller rotates clockwise as viewed from the rear. The engine is mounted to a tubular engine mount ring with eight vibration isolators. The engine mount assembly is bolted to the main firewall at four points.

5. Background.

a. Requirement. The US Army Aviation Materiel Command (USAAVCOM) has established a comprehensive program of qualifying spark plugs for a number of aircraft-engine combinations to ease the management of the overall spark plug program and to broaden the procurement base.

b. Spark Plug Test Program. A series of flight tests have been conducted by the US Army Aviation Test Board (USAAVNTBD) under the sponsorship of USAAVCOM to qualify additional spark plugs for each aircraft-engine combination. This test was one of the series.

c. MIL-S-7886/1002 (MO). Military Specification 7886/1002 (MO) was published to establish qualification criteria for type I, fine-wire, platinum-electrode spark plugs.

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d. Criteria. The objectives of this test program have been specifically selected and oriented to answer the requirements of MIL-S-7886/1002 (MO) (inclosure 1) which contains the criteria for the conduct of this test.

6. Scope.

Military potential testing of PL 300 spark plugs in an R2000-7M2 engine installed in CV-2 airplane, serial number 57-3083, was conducted from 1 November 1965 through 27 January 1966. A total of 225.5 operating hours was accomplished. Throughout the test period, a record was maintained of spark plug malfunctions and failures to include hours attained, cause of failure (if determinable), and cylinder location where each spark plug was installed. All test spark plugs were photographed, inspected, and tested at termination of the test, or when a failure or malfunction occurred. The condition of each spark plug with respect to carbon deposits, oil deposits, lead deposits, bridged electrodes, electrode deterioration, gap growth, flash-over conditions, and the existence of cracked insulator tips and bonds was noted.

7. Summary of Results.

a. Four test spark plugs (figure 1) failed at 224.5 hours. These spark plugs were installed in cylinders No. 3 front, No. 4 rear, No. 7 front, and No. 11 front. The spark plugs were removed and inspected in accordance with MIL-S-7886/1002 (MO). Reasons for failures could not be determined.

b. Seven additional spark plugs (figure 2) failed at 225.5 operating hours. The spark plugs were removed and inspected in accordance with MIL-S-7886/1002 (MO). This inspection revealed that the spark plugs installed in cylinders No. 1 rear, No. 2 front, No. 6 front, No. 8 front, No. 8 rear, No. 9 rear, and No. 10 rear were breaking down under pressure, resulting in intermittent firing.

c. A visual inspection of all the spark plugs tested revealed no evidence of oil deposits, lead deposits, bridged electrodes, or cracks in the insulator tips and bonds; however, some evidence of carbon deposits, electrode deterioration, and flash-over conditions existed.

d. No significant difference in appearance existed between the spark plugs that failed and those that functioned properly (see figure 3).

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e. The spark plug electrode gaps were set at 0.016 inch (+0.002, -0.001) prior to initial installation. Electrode gaps at 225.5 operating hours are listed below:

Right Engine

No. 1 Cylinder

Front - 0.022 inch; rear ~ 0.021 inch

No. 2 Cylinder

Front - 0.024 inch; rear ~ 0.022 inch

No. 3 Cylinder

Front - 0.021 inch; rear ~ 0.022 inch

No. 4 Cylinder

Front - 0.023 inch; rear ~ 0.022 inch

No. 5 Cylinder

Front - 0.023 inch; rear ~ 0.021 inch

No. 6 Cylinder

Front - 0.025 inch; rear ~ 0.022 inch

No. 7 Cylinder

Front - 0.023 inch; rear ~ 0.023 inch

No. 8 Cylinder

Front - 0.024 inch; rear ~ 0.023 inch

No. 9 Cylinder

Front - 0.023 inch; rear ~ 0.024 inch

No. 10 Cylinder

Front - 0.024 inch; rear ~ 0.026 inch

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No. 11 Cylinder

Front - 0.022 inch; rear - 0.022 inch

No. 12 Cylinder

Front - 0.021 inch; rear - 0.021 inch

No. 13 Cylinder

Front - 0.021 inch; rear - 0.021 inch

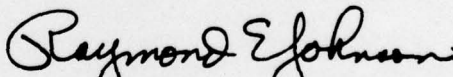
No. 14 Cylinder

Front - 0.023 inch; rear - 0.023 inch

f. The test was terminated at 225.5 operating hours because the spark plugs exceeded the failure rate specified in MIL-S-7886/1002 (MO) (inclosure 1).

8. Conclusion. The PL 300 spark plugs are not suitable for operation in the R2000-7M2 engine because they fail to meet Military Specification MIL-S-7886/1002 (MO).

9. Recommendation. It is recommended that no further testing be conducted on the PL 300 spark plugs installed in the R2000-7M2 engine.



RAYMOND E. JOHNSON
Colonel, Artillery
President

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as

Distribution:
See page 6

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Spark Plugs, PL 300, USATECOM Project No. 4-6-5400-01

Distribution (continued):

Commanding General 2 copies
US Army Test and Evaluation Command
ATTN: AMSTE-BG
Aberdeen Proving Ground, Maryland 21005

Commanding General 6 copies
US Army Aviation Materiel Command
ATTN: SMOSM-EGCG
12th and Spruce Streets
St. Louis, Missouri 63166

MIL-S-7886/1002 (MO)

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MILITARY SPECIFICATION

SPARK PLUGS: SHIELDED, FINE WIRE PLATINUM ELECTRODE,
TYPE 1 FOR AIRCRAFT RECIPRO-
CATING ENGINES

1. SCOPE

1.1. This specification covers type 1, fine wire platinum
electrode spark plug for:

<u>Aircraft</u>	<u>Using engine</u>
UH-19D	R-1300-3
CH-21C	R-1820-103
CH-34	R-1820-84
CH-37	R-2800-54
CV-2	R-2000-7M2
OH-13S	O-435-25

2. APPLICABLE DOCUMENTS

2.1. The following documents of the issue in effect on date
of invitation for bids or request for proposal, form a part
of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

P-2-661

Solvent, Dry-Cleaning

MILITARY

MIL-O-6081

MIL-S-7886

Oil, Lubricating, Jet Engine
Spark Plug, Shielded, Aircraft
Reciprocating Engine, General
Specification for

encl 1

STANDARD

ARMY-NAVY AERONAUTICAL

AN4027

Gasket--Spark Plug

(Copies of specifications and standard required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

1. REQUIREMENTS

3.1. Qualification. -- Spark plug shall be a product which has passed the qualification tests in accordance with Specification MIL-S-7886; which has been listed, or approved for listing, on the applicable qualified products list for the engine-airframe combination specified in table I; and which is in compliance with this specification.

3.2. Performance reliability. -- Spark plug shall be capable of operating satisfactorily without fouling or other evidence of electrical or mechanical failure when subjected to the flight tests specified in 4.2.

4. QUALITY ASSURANCE PROVISIONS

4.1. Test conditions. --

4.1.1. Engine. -- Only an engine in proper mechanical and electrical condition, having sufficient time before the next overhaul for the flight test involved, shall be used for the testing of the spark plugs. Bushing threads in the cylinder shall be cleaned of carbon and other foreign matter. The maintenance inspection of the engine shall also include a check on (1) the compression and (2) the ignition components including coils breaker points, condenser, ignition harness, distributor, and magneto timing.

4.1.2. Identification of plugs. -- Prior to installation of each complete set of test plugs, of the same part number, each plug shall be permanently marked by etching to indicate cylinder number and position.

4.1.3. Gasket. -- Whenever a plug is installed, a new gasket conforming to Standard AN 4027 shall be used.

4.1.4. Torque. -- Plugs shall be tightened to the torque specified for the test condition, preferably to the high limits, as specified in Specification MIL-S-7886.

4.1.5. Lubrication. -- Whenever a plug is removed for inspection, the threads shall be lubricated with engine oil conforming to grade 1010 of Specification MIL-O-6081, prior to its reinstallation.

4.2. Tests. -- Spark plugs shall be tested under controlled, and under other than controlled, flight conditions, as specified below. Engine-airframe combinations, fuel, electrode gap, flight hours, and allowable number of spark plug failures for each engine, shall be as specified in table I.

TABLE I. -- Engine-airframe combinations.

<u>Engine</u>	<u>Aircraft</u>	<u>Fuel</u>	<u>Electrode gap (inch)</u>	<u>Flight hours</u>	<u>Plug failures per engine</u>
R-1300-3	UH-19D	115/145	.015/.018	400	3
R-1820-103	CH-21C	115/145	.015/.018	400	4
R-1820-84	CH-34	115/145	.015/.018	400	4
R-2800-54	CH-37	115/145	.015/.018	400	8
R-2000-7M2	CV-2	115/145	.015/.018	400	6
O-435-25	OH-13S	115/145	.015/.018	400	3

4.2.1. Controlled flight. -- At the beginning of the controlled flight tests, and at approximately every 100 hours of flight time thereafter, the following three tests, for both rotary wing and fixed wing, shall be successfully accomplished three times:

4.2.1.1. Rotary wing. --

4.2.1.1.1. Lifting and hovering capability. -- Engine shall be allowed to idle in auto rich for 15 minutes, using normal defouling procedures. Engine shall then be capable of lifting and hovering the craft with its maximum military load until highest permissible engine cylinder head temperature is reached.

4.2.1.1.2. Maximum rate of climb and power. -- After engine cools to normal operating temperature, it shall be capable of taking off and maintaining maximum rate of climb to the aircraft maximum operating altitude, followed by a 15-minute cruise at low power to cool and stabilize engine temperatures, then a level course maintained at maximum except takeoff (METO) for 5 minutes, followed by maximum endurance power for 30 minutes.

4.2.1.1.3. Cruise power and autorotation. -- Engine shall be cruised at low power for 15 minutes, cool the engine, and autorotated to a safe recovery altitude, followed by level flight at cruise power for 30 minutes.

4.2.1.2. Fixed wing. --

4.2.1.2.1. Maximum rate of climb with maximum military load. -- Engine shall be allowed to idle in auto rich for 15 minutes, using normal defouling procedures. Engine shall then be capable of maintaining maximum rate of climb with maximum military load from point of takeoff to the aircraft maximum operating altitude.

4.2.1.2.2. Cruise and maximum endurance power. -- The engine shall then be operated for 15 minutes at approximately 65-percent power in cruise to cool and stabilize engine temperatures, followed by maximum except takeoff (METO) power for 5 minutes, and then at maximum endurance power for 30 minutes.

4.2.1.2.3. Cruise, glide, and level flight. -- Then cruise shall be at approximately 65-percent power for another 15 minutes to cool the engine, followed by a 2-minute glide at 20 percent power, and again at approximately 65-percent power in level flight for 15 minutes.

4.2.2. Other than controlled flight. -- Flight time other than controlled shall be under normal service conditions and in accordance with applicable technical data relating to performance of typical maneuvers normally associated with observation, resupply, communication relay, and similar type missions.

4.3. Inspections. --

4.3.1. Intervals. -- Plugs shall be tested without their removal by using an ignition analyzer at 50, 100, 150, 200, 250, 300, 350, and 400 hours, to determine whether the plugs in each cylinder function properly.

4.3.1.1. Malfunctioning plugs. -- Any plug showing indication of malfunctioning shall be removed from the engine and visually inspected. If oil-fouled, it shall be cleaned by soaking the firing end and cavity for 30 minutes in solvent conforming to Specification P-8-661 and draining and drying it thoroughly with a filtered airblast. A light abrasive-blast cleaning is permissible if necessary to remove hardened oil deposits. In addition, the ceramic shielding barrel shall be thoroughly cleaned. The electrode gaps shall be measured with a round wire gage. (Plugs shall not be regapped.) Plug shall be placed in a spark plug tester such as the AV 18-1 manufactured by AC Spark Plug Div. of General Motors Corp., or equivalent. Tester shall be connected to a single-phase 110-120 volt, 60-cycle power supply outlet. Nitrogen gas shall be used in the pressure chamber: for spark plug electrode gaps under .020-inch, 200 psi; for gaps over .020-inch, 175 psi. If plug fires under these conditions, it should be reinstalled in same position in the engine, using a new gasket conforming to Standard AN4027.

4.3.1.2. Plug failures. -- Plugs other than oil-fouled, or showing obvious mechanical failure, shall be tested in a spark plug tester (see 4.3.1.1). Any plug failing to fire shall be considered a failed plug. Plug failures due to other than normal flight test conditions are not to be considered plug failures and shall be replaced with like new items. Cracked ceramic insulators, electrode failures, chromic fuel and lead fouling, or other bonafide failures are considered plug failures.

4.3.2. Final examination. -- At the completion of 400 flight hours, plugs shall be removed from the engine and given final inspection. This shall include visual inspection, final gap measurement, and testing in spark plug tester as specified in 4.3.1.1. Results of these inspections shall be shown on test report indicating the performance of each set of spark plugs under tests and examinations specified herein.

Test stoppage. -- If more than the allowable number of failures occurs before completion of flight hours scheduled (see table 1), test shall be stopped.

5. PREPARATION FOR DELIVERY

5.1. Preparation for delivery shall be in accordance with section 5 of Specification MIL-S-7886.

NOTES

4.1. Intended use. -- Type 1 spark plug is intended for use with the engine-airframe combinations specified in 4.2.

4.2. Ordering data. -- Ordering data shall be in accordance with Specification MIL-S-7886.

4.3. Qualification. -- With respect to products requiring qualification, awards will be made only for such products as have, prior to the bid opening date, been tested and approved for inclusion in the applicable qualified products list, whether or not such products have actually been listed thereon by that date. The attention of suppliers is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order to be eligible to be awarded contracts or orders for the product covered by this specification. The activity responsible for the qualified products list is the U. S. Army Mobility Command, Warren, Michigan; however, information pertaining to qualification of products may be obtained from the Commanding General, U. S. Army Aviation and Surface Materiel Command, AFPM: Directorate of Engineering, P. O. Box 209, Main Office, St Louis, Missouri 63166

PHOTOGRAPHS

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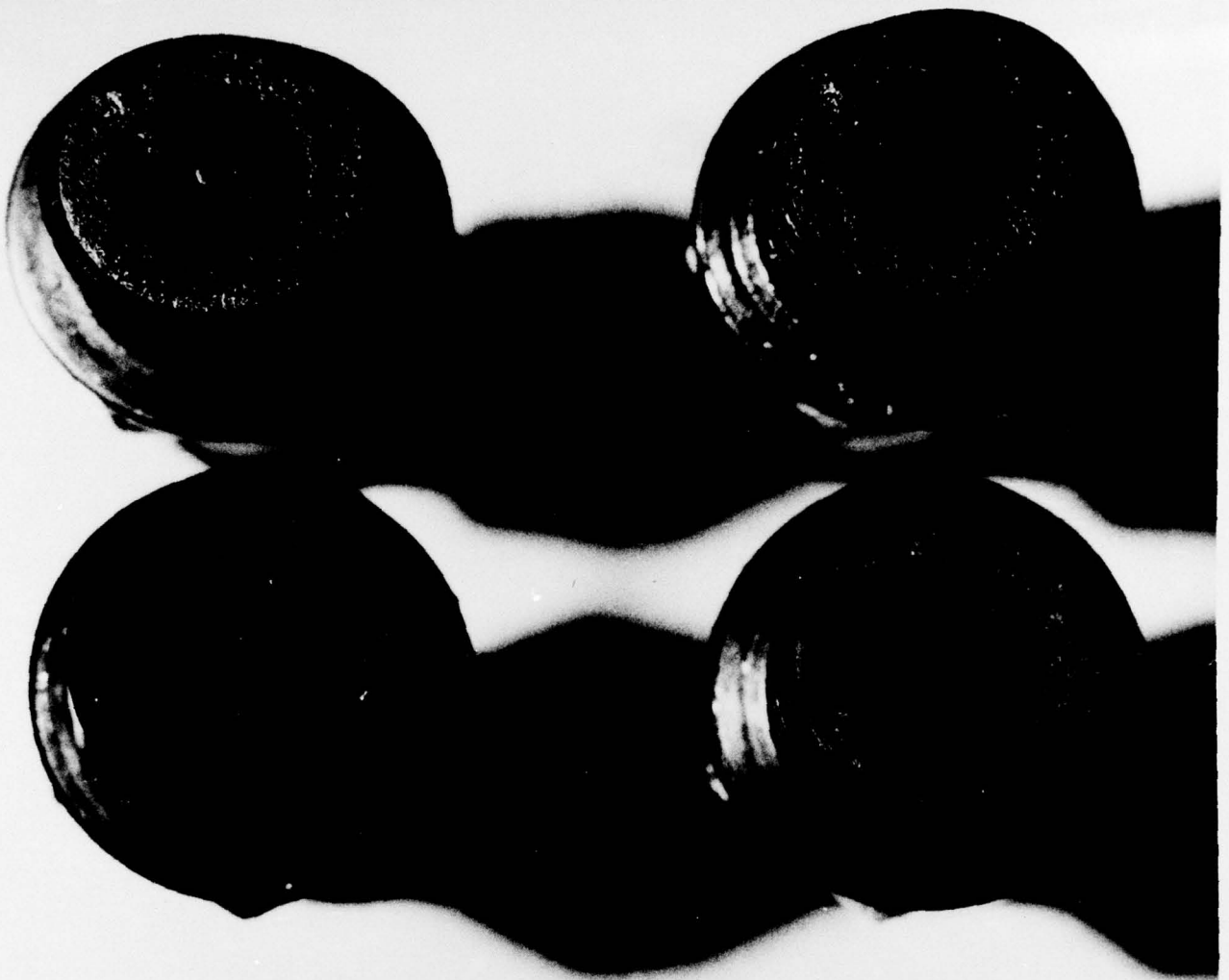


Figure 1



Figure 2

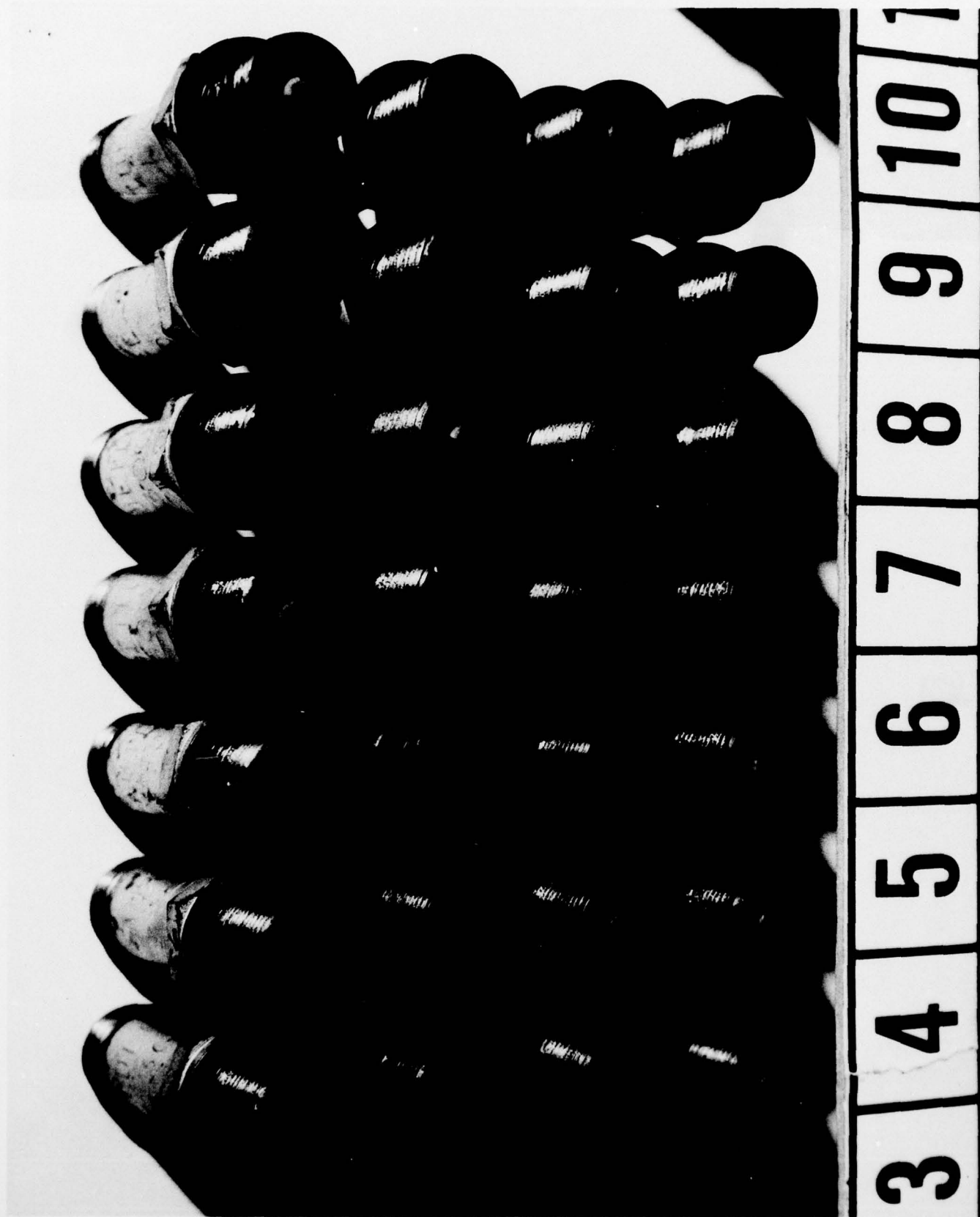


Figure 3